AD-A149 757 ONR HLF-3 SOURCE OPERATIONS FOR MIZEX 84(U) 1/1
HYDROACOUSTICS INC ROCHESTER NY E D MCCLOSKEY OCT 84
HA-122-84 N00014-84-C-0177

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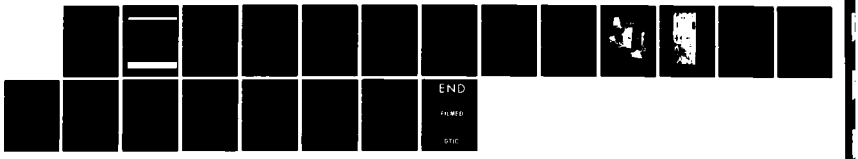

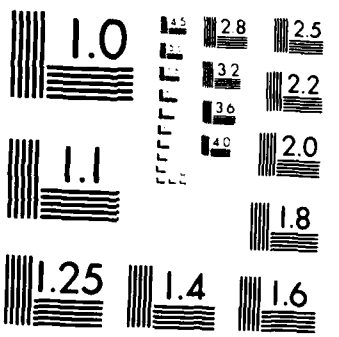

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Report No. HA 122-84

AD-A149 757

FINAL REPORT

ONR HLF-3 SOURCE OPERATIONS

FOR

MIZEX 84

DTIC FILE COPY

October 1984

HYDROACOUSTICS INC.

85

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FINAL REPORT

ONR HLF-3 SOURCE OPERATIONS

FOR

MIZEX 84

Prepared Under Contract
N00014-84-C-0177

October 1984

Submitted to:

Office of Naval Research
Arctic Program Office
Code 425R
800 North Quincy Street
Arlington, VA 22217

Attention: Dr. Robert Obrachta

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: HA 122-84	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): FINAL REPORT ONR HLF-3 SOURCE OPERATIONS FOR MIZEX '84(U)	5. TYPE OF REPORT & PERIOD COVERED: FINAL REPORT 3rd QUARTER 1984
6. PERFORMING ORG. REPORT NUMBER: HA 122-84	
7. AUTHOR(s): E. DANIEL McCLOSKEY	8. CONTRACT OR GRANT NUMBER(s): N00014-84-C-0177
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Hydroacoustics Inc. 999 Lehigh Station Rd., P.O. Box 23447 Rochester, New York 14692	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Office of Naval Research 800 North Quincy Street Arlington, VA 22217	12. REPORT DATE: October 1984
	13. NUMBER OF PAGES: Sixteen (16)
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Office of Naval Research 800 North Quincy Street Arlington, VA 22217	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

Distribution of this document is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

None

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Mizex '84
Fram Strait
USNS Lynch
HLF-3 Low Frequency Projector

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This final report briefly describes the preparation, system checkout, and tow operations of the ONR HLF-3 for the MIZEX '84 experiment in the FRAM STRAIT. The HLF-3 low frequency acoustic projector was towed during June, 1984 from the U.S.N.S. LYNCH in the Greenland Sea. The projector was towed at speeds up to nine knots and at depths between 100 and 110 meters during two tow periods totalling 201 hours of

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source operation. The HLF-3 transmitted single tones, multiple tones, and noise between 25 and 275 Hz at levels to 194 dB re 1 μPa @ 1m.

TABLE OF CONTENTS

1.0 SUMMARY

The ONR HLF-3 Sound Source has supported numerous acoustic sea tests since 1977. Prior to the MIZEX experiment the Sound Source had accumulated approximately 14000 tow miles on various types of ships in the North Pacific and North Atlantic Oceans and the Norwegian and Barents Seas. During these tow operations the source has exhibited an extremely high degree of reliability accumulating less than seven days of down time.

In preparation for MIZEX 84, the Sound Source was refurbished, it's spares complement was replenished, and a System Checkout was completed at the NUSC Seneca Lake Facility. The result of this preparation was an uneventful 291 hours (approximately 2300 tow miles) of operation during the MIZEX experiment. The source was towed at a nominal depth of 100 meters during the first tow period and at a nominal depth of 110 meters during the second tow period.

During the MIZEX experiment, the NUSC RONDO signal generator provided the necessary signal waveforms for the HLF-3 Sound Source. The internal disk mounted accelerometers and the tow-body mounted F-37 hydrophone, both measures of the far field sound pressure level, were monitored on a NICOLET Model 446A spectrum analyzer provided by NRL. In addition to the annotated output of the spectrum analyzer, a hourly hand written log of the source depth, sea water temperature at the source, and the levels of the fundamental(s) as measured on the disk accelerometers and the tow-body mounted hydrophone, was maintained during source operations.

2.0 ONR HLF-3 SOUND SOURCE

The major components of the HLF-3 sound source system are the sound source mounted in a tow body, a faired tow cable, a topside motor starter (440 VAC, 3-PHASE), a FM telemetry system, and a topside monitor-controller.

The sound source is a short cylinder, 47 inches in diameter and 20 inches long. Two center-driven, steel alloy flexural disk radiators are mounted back-to-back on a cylindrical aluminum housing. The housing is a spoke stiffened 6061 aluminum alloy ring which serves to mount the flexural disk radiators and contains all the submersible components of the system. The drive piston assembly, hydroacoustic circuits, five horsepower hydraulic power supply, and various electronic sensors and components are contained within the housing.

Each radiator is center driven by a piston in a common sleeve in the center of the housing. The pistons are supported in their bore by hydrostatic bearings. Hydraulic fluid under pressure is introduced between the pistons by the hydroacoustic amplifier driving the radiators.

Hydraulic power for the hydroacoustic amplifier and hydrostatic piston bearings is provided by a fixed displacement multistage gear type hydraulic pump-motor combination. The lower portion of the housing collects the return flow from the hydroacoustic amplifier and the hydrostatic bearings and serves as a reservoir and heat transfer unit for the hydraulic oil.

The ONR HLF-3 sound source mounted in a tow body equipped with pressure compensated base is shown in Figure 2.1. The nose section reduces the overall drag of the unit and provides part of the structure between the upper and lower parts of the tow body.

The near-field, tow body mounted F-37 hydrophone and the sea temperature probe are mounted via a support to the upper part of the tow body. The tow point (not shown) attaches to the upper part of the tow body just forward of the hydrophone support.

The tow cable used on the MIZEX 84 experiment is a torque-balance electromechanical cable approximately 270 meters in length. This tow cable is equipped with 45 meters of FATHOM FLEXNOSE fairing. Approximately 140 meters of FATHOM RIGSTREAM fairing is available for installation on this cable abaft the tow sheave. The tow cable used with the compensated source is 880 meters in length and is equipped with 235 meters of FATHOM FLEXNOSE fairing and 550 meters of ZIPPERTUBING fairing. Each tow cable has three No. 10 power leads, two coaxes, a twisted pair and six single conductors for use with the static sensors.

Figure 2.2 shows the monitor-controller and the telemetry receiver.

Figure 2.3 is the far-field response for various input levels of the ONR HLF-3 sound source.

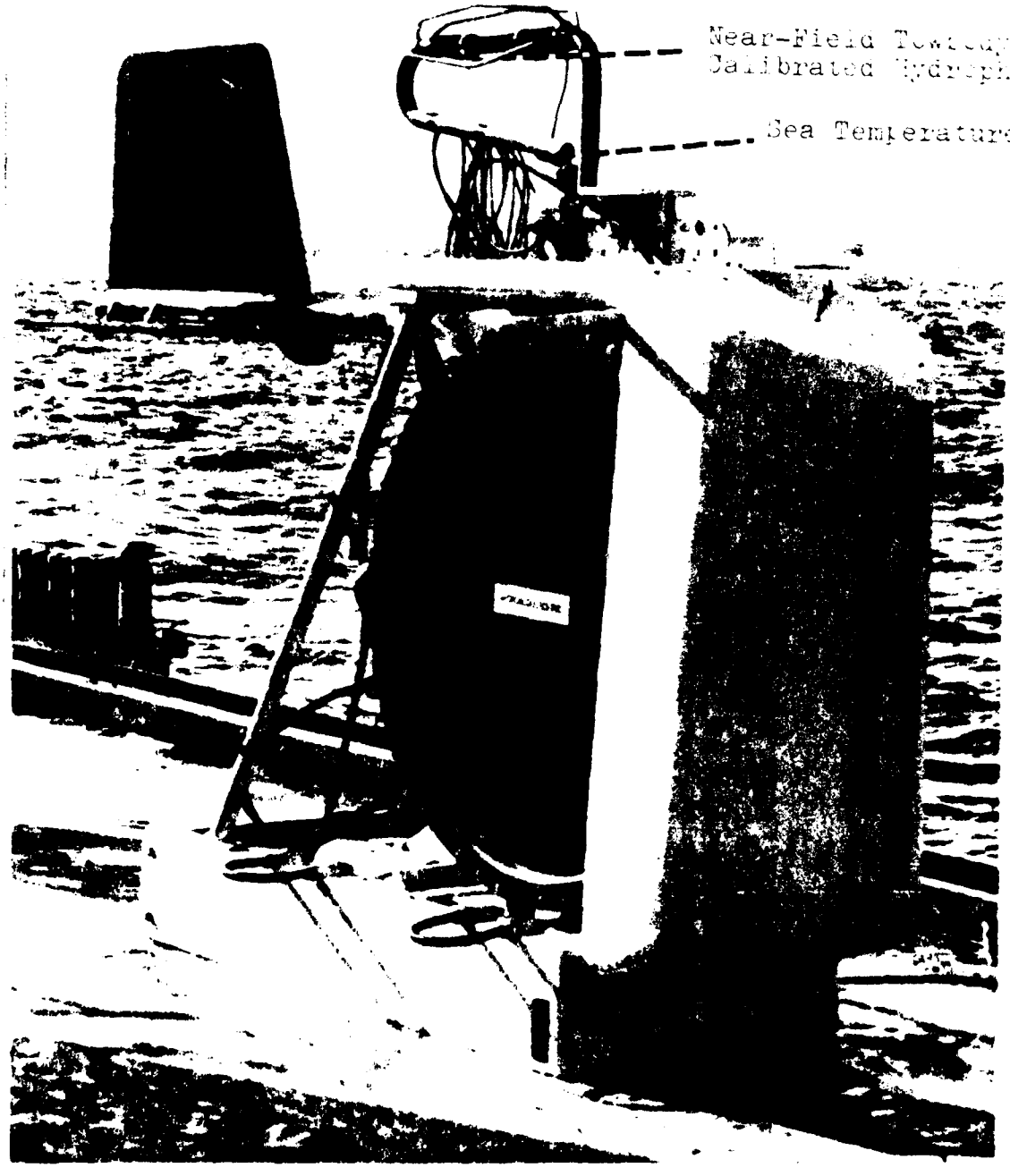

Figure 2.1 ONR HLF-3 Sound Source

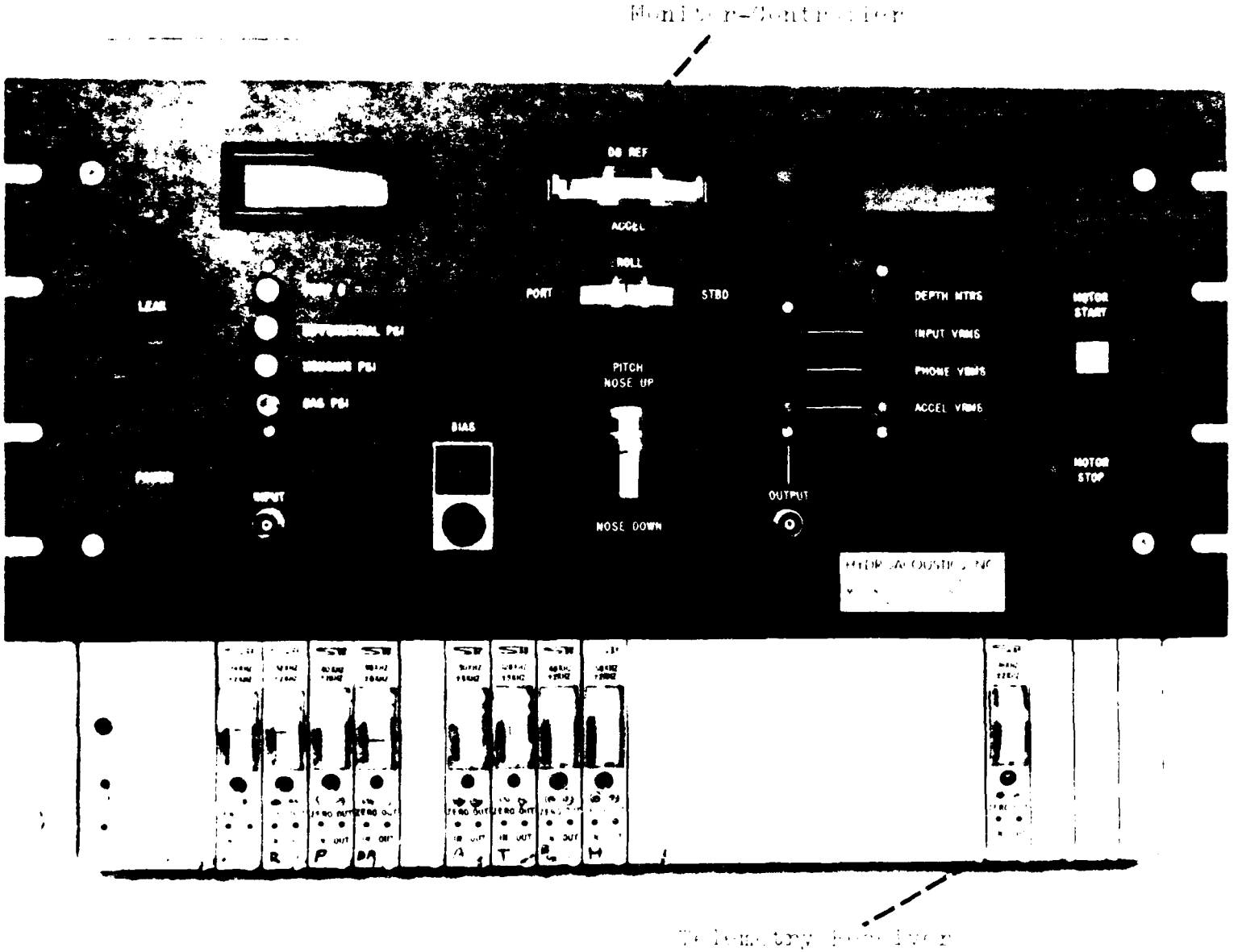

Figure 2.2 ONR HLF-3 Topside Electronics

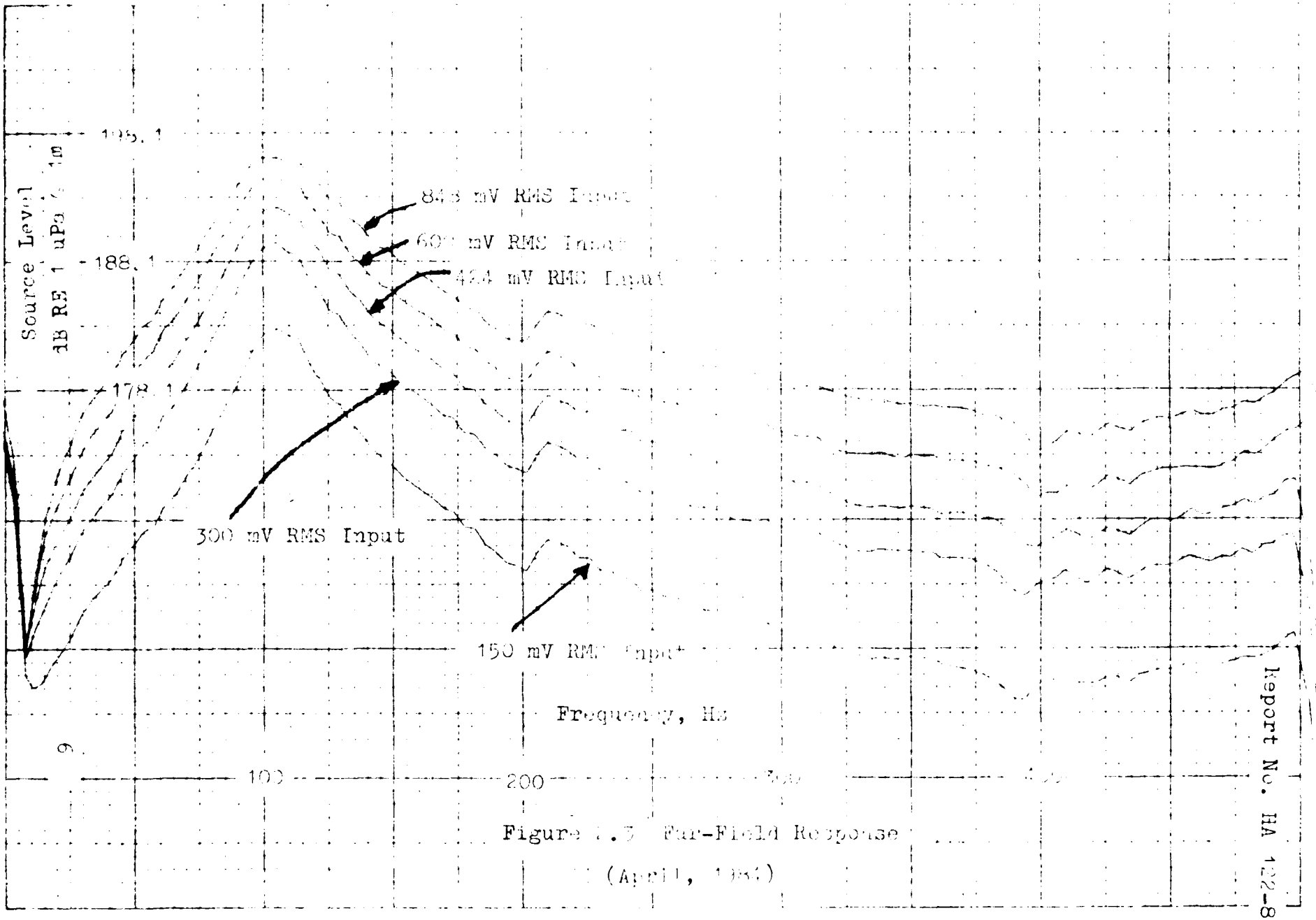

Figure [illegible] Far-Field Response

(April, 1984)

3.0 PREPARATION FOR THE TOW OPERATIONS

In preparation for the MIZEX experiment, the HLF-3 Sound Source was renovated, the spares complement was inventoried and updated, and a System Checkout was conducted at the NUSC Seneca Lake facility. The renovation of the source consisted of installing the original tow body base, checking the watertight integrity of the source, performing normal hydraulic maintenance, and calibrating the various sensors. The original tow body base decreases the overall height of the sound source thereby increasing the clearance between the sound source and the transom of the ship. The tow body base that was replaced, contained nitrogen bottles for the compensated version of the sound source. The base for the compensated version of the source presents more underside area that effects the towing performance in heavy weather. The tow body base bolts that attach the source to the tow body were drilled and pinned to eliminate the loosening of the bolts as occurred during the RONDO experiment. The tow body used during MIXEZ is approximately ten years old and is beginning to show signs of the numerous tow miles.

All external seals were replaced and their mating surfaces were polished to insure the watertight integrity of the sound source. A vacuum purged the source of moisture and nitrogen was added to provide a precharge for the pump. The level of the precharge was observed over a period of time to gather confidence in the watertight integrity of the source.

Normal hydraulic maintenance was performed on the source. This maintenance included changing the filters and checking the hydraulic fittings for leaks. The interior of the source was cleaned to eliminate possible contaminants.

The depth and sea water sensors and their associated electronics were calibrated in their final configuration. The hydrophone preamplifier calibration was verified.

The spares complement for the sound source and the related equipment required to handle and service the sound source on an extended operation were inventoried, replenished, updated, and packed for overseas shipment.

A System Check of the ONR HLF-3 was completed at the NUSC Seneca Lake Facility between April 9 and April 11, 1984 in conjunction with the NUSC HLF-3 ARCTIC sound source. The System Check included the sound source, the new tow cable and the topside electronics. The ONR HLF-3 was lowered to a depth of 100 meters. This depth provided a check of the watertight integrity of the sound source and the new connectors on the new tow cable. The disk mounted accelerometers and tow-body mounted F-37 hydrophone were calibrated against a far-field F-37 Hydrophone from 20 Hz to 400 Hz at two different input levels. A low level random noise input was used to collect Figures 3.1 and 3.2, transfer functions of the accelerometer and tow body mounted hydrophone, respectively. These transfer functions are representative of the data collected during the System Check. Table 1 lists relevant factors associated with the System Check. Spectral data of the far field phone were recorded for each of the waveforms that were to be transmitted during the MIZEX experiment.

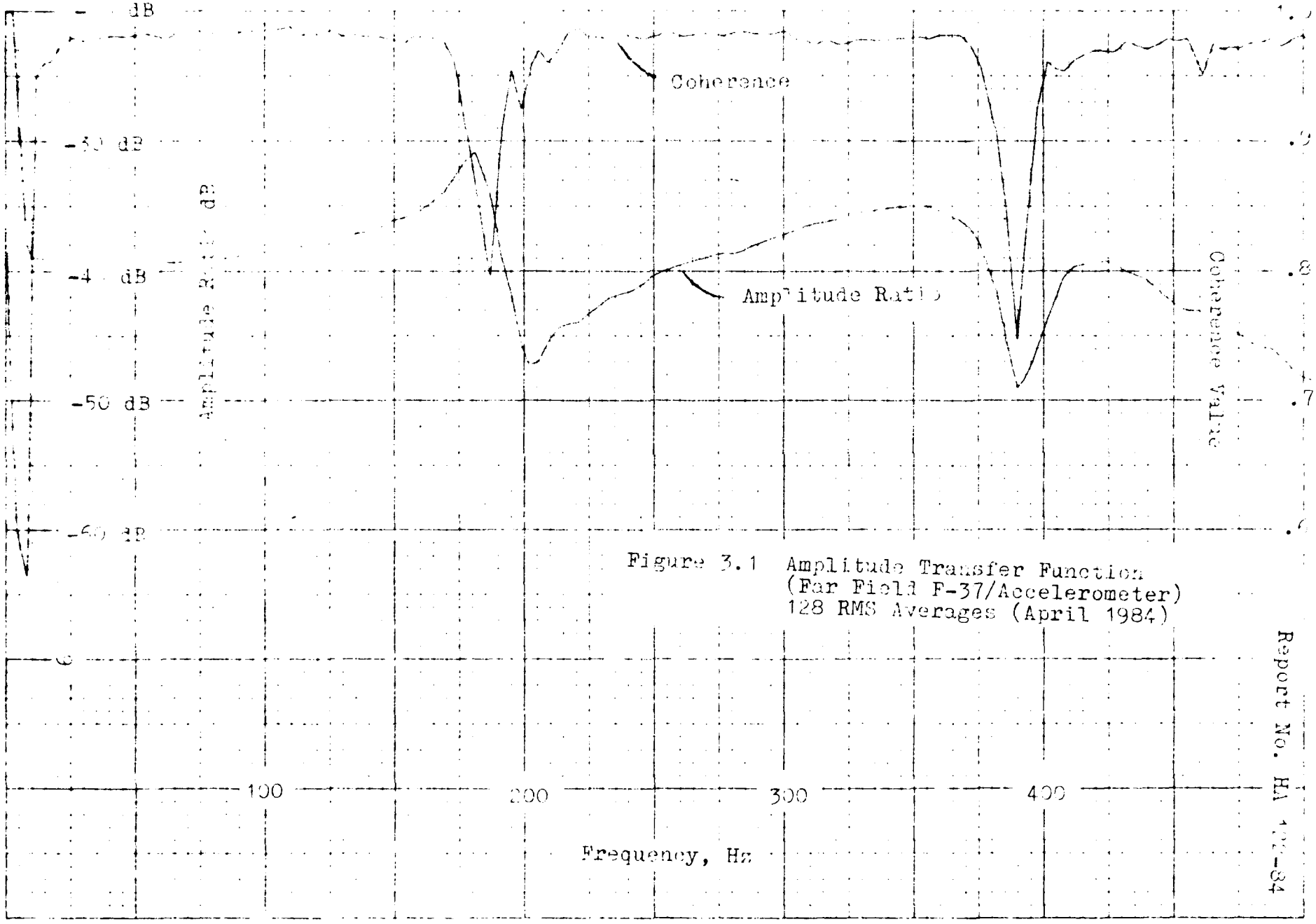

Figure 3.1 Amplitude Transfer Function
(Far Field F-37/Accelerometer)
128 RMS Averages (April 1984)

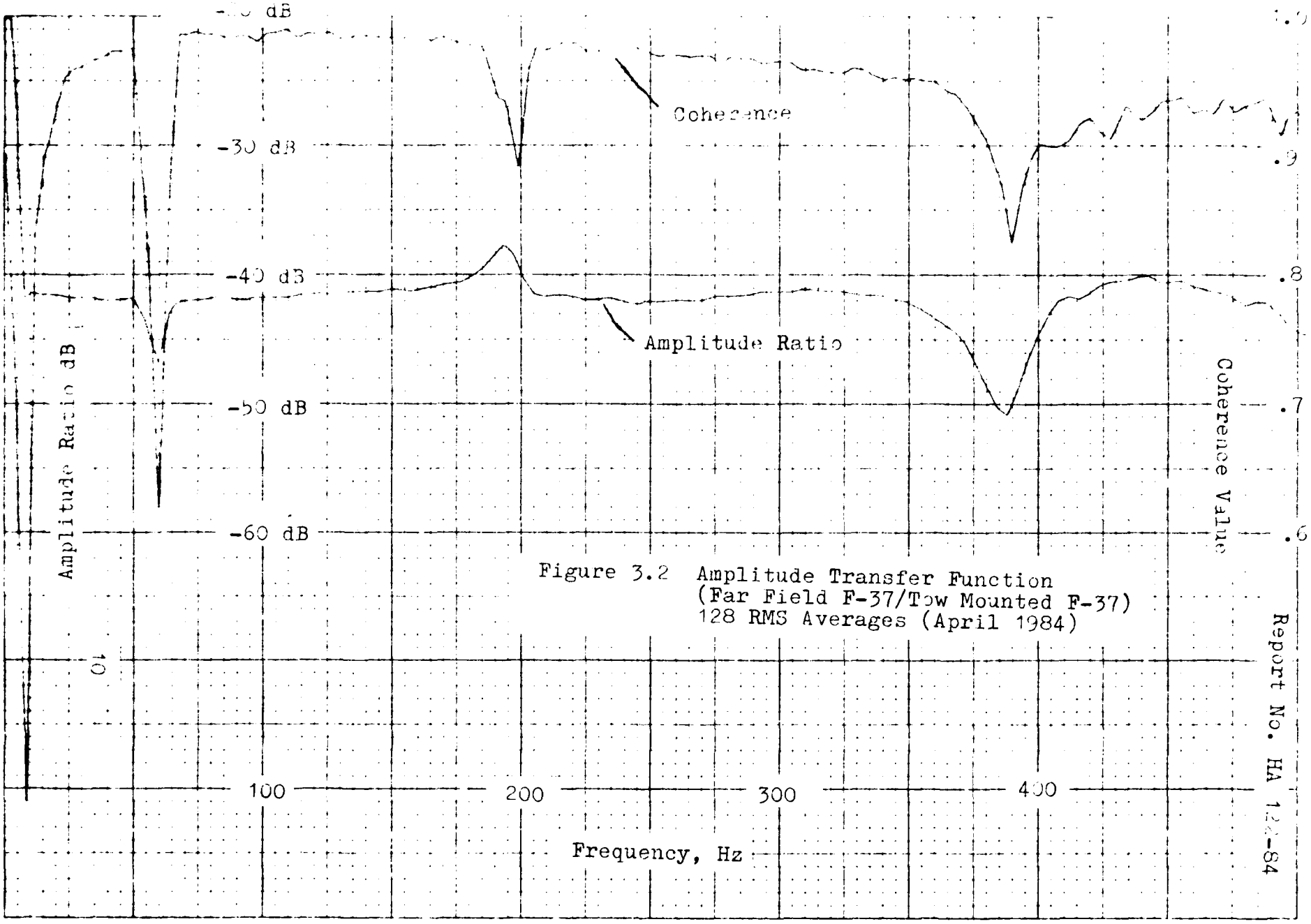

Figure 3.2 Amplitude Transfer Function
(Far Field F-37/Tow Mounted F-37)
128 RMS Averages (April 1984)

Table 1

Depth	100 meters 9-11 April 1984
Far-Field Hydrophone	
F-37 S/N 65	Calibrated October 1983
Sensitivity	-206.4
20 Log 12.2 meters	-21.7
	-228.1 dB// 1 volt/uPa
Near-Field Hydrophone(Theoretical)	
F-37 S/N 276	Calibrated March 1984
Sensitivity	-202.5
20 Log 1.3 meters	-2.3
	-204.8
Gain (wetside)	+20.0
	-184.8 dB//1 volt/uPa
Indicated Depth	
98 meters	98 meters / 100 meters x 1.025 x 100 = 100.4%
Indicated Temperature	
3.9° C	Unknown Absolute
Spectrum Analyzer	Hewlett Packard Model 3582A
Input	10 dB steps Ref. to 0 dBV

Frequency Span Hz	Time Record Length Sec	Calculated Point Spacing Hz	Equivalent Noise Bandwidth Hz
250	1.0	1.0	1.50
500	0.5	2.0	3.00
1000	.25	4.0	6.00

Table 1 Pertinent Calibration Factors
HLF-3 ONR

The effective sensitivity at a frequency(s) of either the accelerometer or the tow body mounted hydrophone is computed by substracting the amplitude ratio from either Figure 3.1 or 3.2 at the required frequency(s) from the sensitivity of the far field hydrophone (-228.1 dB// 1 volt/uPa). For example the effective sensitivity of the tow body mounted hydrophone at 50 Hz is -228.1 dB// 1 volt/uPa (sensitivity of the far field hydrophone) minus -42 dB (amplitude ratio at 50 Hz from Figure 3.2) or -186.1 dB// 1 volt/uPa.

The measured effective sensitivity of the tow body mounted hydrophone computed from the amplitude transfer function of the far field hydrophone to the tow body mounted hydrophone (Figure 3.2) is generally within 1.5 dB of the theoretical sensitivity of the tow body mounted hydrophone shown in Table 1. The difference at 60 Hz is due to electrical interference in the hydrophone cable. The differences at 190 Hz and 380 Hz are due to the mode changes in flexural disk radiators.

At the conclusion of the System Check, the sound source and its related equipment were packed for overseas shipment.

4.0 MIZEX TOW OPERATIONS

The HLF-3 Sound source was installed aboard the USNS LYNCH in Tromso, Norway during the period June 1st through June 4th. The installation required loading the tow cable on the previously installed URI (University of Rhode Island) trawl winch, uncrating and assembling the sound source, installing the support equipment including the tow sheave and handling winches, and conducting in-air and in-water performance checks.

The HLF-3 Sound Source was towed for 291 hours from the USNS LYNCH in the Greenland Sea from June 8th through June 19th and from June 22nd to June 24th. During the source operations, parameters were entered into an hourly log. These parameters included the level of the fundamental(s) as measured on the disk mounted accerlerometers and the tow body mounted F-37 hydrophone, source depth, the sea temperature measured at the sound source, and the transmitted waveform. These parameters in addition to IRIG B time (GMT) and the input level were recorded on magnetic tape (analog) and a strip chart recorder.

The HLF-3 sound source, tow cable, electronics complement, and spares complement were offloaded from the USNS LYNCH in Bayonne, New Jersey on July 16th and 17th and shipped to Hydroacoustics.

5.0 POST EXPERIMENT INSPECTION

At the Hydroacoustics Laboratory, the ONR HLF-3 sound source was uncrated and inspected for damage resulting from the MIZEX experiment. Measurement of the housing precharge indicated the water tight integrity of the sound source had not been compromised during the 193 hours of towing and the related handling. Visual inspection of the source exterior revealed a cracked weld on the towbody nose and worn areas on the exterior paint. A visual inspection of the welds connecting the transducer to the tow body confirmed their integrity. The interior of the transducer was inspected and found to be in order.

The length of the tow cable was not inspected at Hydroacoustics. However, during the final retrieval at sea and during the transfer of the tow cable from the tow winch to the shipping drum, the Hydroacoustic's representative who assisted in these operations did not find any problems with the tow cable or the terminations. It is estimated that approximately 10 meters of the removable Rigstream fairing had been damaged or lost during the experiment.

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